The risk of nuclear accidents: prevention and management

Conversation[a] with **Jean-Christophe Gariel,** Institute for Radiological Protection and Nuclear Safety, and **Sophia Majnoni d'Intignano,** lawyer, former nuclear energy expert at Greenpeace France

There is seldom consensus when it comes to assessing the risk of a nuclear accident and being prepared for one. The issue is fraught with challenges and assumptions. As for handling a potential accident, history has shown that operational decisions and actions depend on the political and social structures of the regions concerned. Opposing views from two experts in the field.

Prior to the Chernobyl disaster, it was left to the discretion of the operator to assess the severity of an accident. After Chernobyl, an International Nuclear Event Scale (INES) was created to describe and classify nuclear incidents and accidents. An accident can involve reactors, fuel pools, as well as waste storage centers (such as the Mayak center in Kyshtym, Russia, also a plutonium production center, and the site of a major accident in 1957 about which the general public was largely unaware).

The main risks identified at French civil nuclear facilities are the fullness of the spent fuel pools at La Hague, the ageing of the production equipment and the risk of an incident at any point in the chain. Also, in France lorries are used for transporting radioactive material (and used more frequently because of reprocessing). Whilst this allows EDF to handle all transport in-house, and results in greater safety control of the fuel cycle overall, it is a fact that accidents involving lorries are more likely than those involving trains.

Taking risks into account

Rare and significant risks are difficult to assess, and they are also difficult for experts and the public to take into account when making decisions. Moreover, in the case of nuclear power, the effects of low-dose radiation are not visible to the naked eye or directly observable in our daily lives. Finally, the debate on risk is marred by the lack of consensus on the effect of exposure to low doses of radioactivity, and the link, for example, with the occupational illnesses of nuclear workers. This concerns the entire chain, including the non-accident stages upstream, such as mining, as well as disposal centers.

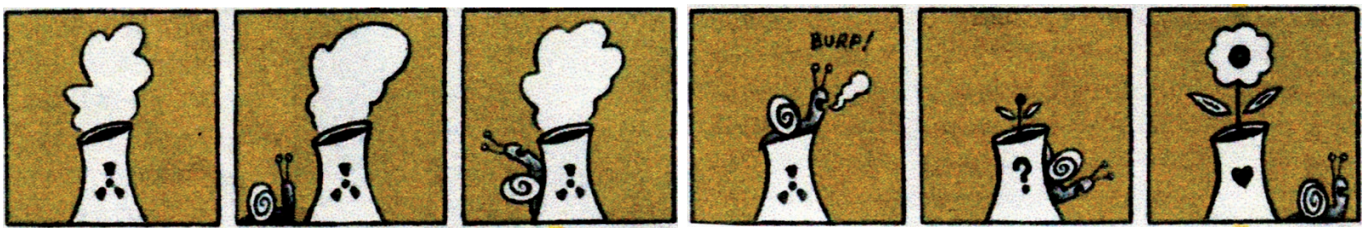
Political decisions and accident preparedness require proper consideration of risk. However, the probabilistic approach, developed for repeatable and insurable events, is less well accepted when applied to significant and rare risks and has long been the subject of deep disagreement between anti-nuclear activists and regulators. The prime example is the risk of aircraft crashes. Moreover, an INES level 7 accident in the middle of a desert might be more politically and socially, but not ecologically, acceptable than a level 6 accident at the Indian Point power plant less than 40 kilometers from New York City. An international risk insurance system has been set up, requiring each reactor to be insured for 750 million euros and in which the state takes over up to 1.5 billion. This compares with the cost of a Fukushima-type disaster, estimated by the Court of Auditors at several hundred billion euros[b].

Risk prevention

Risk prevention is the subject of debate on several points. For example, the Fukushima accident showed that the containment systems, although redundant, could fail. The choice to store high-level waste with a half-life of several thousand years underground raises difficult questions of forecasting, particularly in terms of seismic activity or political risks. Sophia Majnoni d'Intignano stresses that underground storage poses moral problems with regard to future generations; is it better not to publicize the storage facility, or even deliberately count on its being forgotten, or to try to explain its existence (how?) and associated dangers[c]?

It is vital to retain skilled workers for decades or even longer (this applies both to maintenance and dismantling, and in order to be prepared in case of a possible accident). However, the different elements of the nuclear industry are intertwined; any decision, even a small one, can have long-term repercussions for the industry as a whole. For example, even if there are major disagreements about the date, the 15 years old 900 MW reactors will have to be shut down one day. As they are the only ones using "Mixed Uranium and Plutonium Oxide" (MOX) fuel, their closure will have an impact on the Melox plant at Marcoule which manufactures it, on the reprocessing plant at La Hague which supplies the plutonium, and more generally on the industry, its 5,000 jobs, and the expertise of the sector.

For Sophia Majnoni d'Intignano, the solution may lie in the German approach, where an ethics committee incorporates a long-term view, showing that it is possible to recognize a moral, intellectual or societal dimension in the managing of nuclear liabilities for the benefit of future



generations. It is a way of maintaining a positive dynamic in the long term which may be an alternative to or complementary to the development of new nuclear programs, and attracting competent people for decontamination and decommissioning (which will also require sources of funding and energy).

Preparing for a possible accident

Arrangements are in place at local, national and even international levels ready to be implemented in the case of an accident. In Japan, the issue of risk and its management is very important, particularly because of the frequency of earthquakes, and schoolchildren are all aware of them. After Fukushima, Japan's social cohesion made it possible to evacuate the contaminated area, which might not have gone as well in another social group.

To limit panic in an accident situation, it is important to train local communities (about means of transport for residents, temporary accommodation and where to find information), firefighters, pharmacies, etc. Jean-Christophe Gariel emphasizes that protective measures for the general public are aimed at limiting their radiation exposure to as low a level as reasonably possible. The intake of stable iodine is advisable in the event of a release containing radioactive iodine (which may be the case for a nuclear reactor accident for example). It aims, by early saturation of the thyroid gland, to limit the absorption of radioactive iodine by this gland. In France, at present, it is the people living less than 15 km from a nuclear reactor (i.e. in the zone known as the "special intervention perimeter") who are specifically informed about the nuclear risk, who take part in a nuclear exercise and who can find potassium iodide tablets in their local pharmacy. It could be useful to extend these zones, given that 75% of people in mainland France live less than 75 km from a nuclear reactor; for them, iodine is available from regional suppliers.

Some accidents may require a very quick response. Large and short-term discharges can lead to residents being asked to take shelter. Jean-Christophe Gariel points out that this reduces both exposure to external radiation and the risk of breathing in contaminated air. This type of measure can be implemented for a period of about twelve hours, or even several days if it has been appropriately planned for in good conditions, although by then the air inside the buildings may also be contaminated. However, one might wonder about the degree of compliance of the people concerned: for example, who would agree to leave their children in the care of a school?

The protective measures to be taken in an emergency are determined in advance and depend on the particular situation. The advice to take stable iodine is disseminated through the media, specifying when and how it is to be taken, who is affected and who has priority (children and pregnant women in particular). At the same time, public security measures (e.g. traffic restrictions on public roads) and law enforcement measures are implemented. The local authority may decide to restrict the consumption of certain foods or specific activities. Finally, a decision to evacuate the area may be taken, in which case the public authorities will have to take care of people who are not self-sufficient.

The post-accident phase

In the post-accident phase, the primary issues of concern relate to the quality of the environment, public health, the continuity of social and economic life and international relations. At this point the decisions are taken nationally, and decision-making may closely involve the various stakeholders, primarily the inhabitants of the affected areas. How do we determine the size of restricted or even completely prohibited areas? Is it better to allow a population to live in contact with doses of radioactivity that are higher than the standards (and up to what limit), or is it better to close off an area by keeping people out and ceasing all activity?

Therefore, the question of the effect of low doses of radiation has far-reaching practical consequences. There are areas with low levels of contamination that we may want to be able to inhabit for social, human and economic reasons. However, below a certain dose, it is not possible to determine statistically significant effects, nor is it possible to extrapolate to low doses what is known about the effects of medium and high doses. If defining a threshold is impossible, the principle guiding political action is to minimize, whatever happens, the dose of radioactivity that can be added to the background dose, by influencing behavior (diet, routines) and by encouraging those affected to take radioactivity measurements. Politicians must decide on the various measures by weighing up all the risks and consequences: environmental, social and economic. ▮

a. See the introduction to the conversations by F. Graner and S. M. Panebianco (p. 18).

b. See the article by A.-S. Dessillons (p. 29).

c. Olivier Le Naire, « Enfouissement des déchets nucléaires: comment alerter nos descendants? », lexpress.fr, 8 November 2014, www.lexpress.fr/actualite/sciences/enfouissement-des-dechets-nucleaires-comment-alerter-nos-descendants_1619017.html